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(54) A method and a device for monitoring the external integrity of cigarettes

(57) The external integrity of cigarettes is verified by a method that involves directing single cigarettes (2), carried on a conveyor (3), along a route of which one section affords a monitoring path (8) equipped with a line scan camera (11); the advancing cigarette (2) can be made selectively to rotate about its longitudinal axis whilst the camera (11), a solid state type using CCD arrays, makes a succession of scans on respective closely ordered parallel lines (10), which are pulsed at a programmed frequency and synchronously with the movement of the cigarette (2) in such a way that each successive scan line will fall on one and the same generator (2a) of the cylindrical surface. Repeated scanning of the same limited surface area eliminates quality control errors attributable to the presence of particulates in the space between the cigarettes (2) and the camera (11).

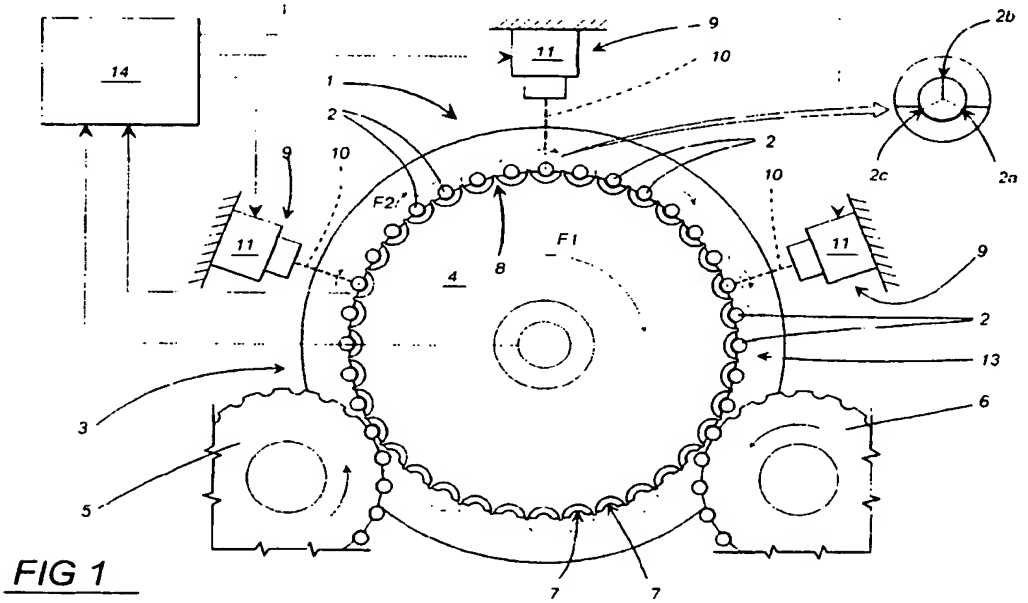

FIG 1

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Description

The present invention relates to a method of verifying the external integrity of cigarettes.

In particular, the invention is pertinent to a method of the aforementioned type such as can be employed, preferably, in cigarette manufacturing machines.

It is standard practice in the art field of cigarette manufacture to verify the external integrity of the finished cigarettes by causing the single cigarettes to advance in succession, with their respective axes disposed transversely to the direction of movement, along a predetermined monitoring path extending past an optical quality control device located following a manufacturing unit in the feed direction.

The quality control device in question is designed to sample a limited number of generators delineating the outer surface of each cigarette produced, by reading images of these same sample generators and comparing each registered image with a model or reference image, to the end of indicating any superficial defects of manufacture that might be present (e.g. badly formed and/or obstructed ventilation holes, edges not gummed, incorrect positioning and/or strength of print, etc.) and thus establishing whether or not the cigarette is of acceptable quality.

The quality control device consists generally in a solid state camera with a CCD array, familiar to those skilled in the art as a Line Scan Camera which as the name implies is designed to read an object by scanning a single line. In operation, the scan line falls on a sample generator of the outer surface presented by the cigarette passing in front of the camera at a given moment.

It is usual to scan a plurality of sample generators per single cigarette, utilizing a plurality of cameras ranged along the monitoring path accordingly, the cigarette is made to rotate around its longitudinal axis while progressing from one camera to the next, so that a different generator will be presented to each camera in turn.

A monitoring method of the type outlined above betrays the drawback that in the event of foreign matter (such as specks of dust, particulates, tobacco filler, etc.) occupying the space in between the cigarette and the optical device during the reading operation, this is interpreted by the device as a flaw and the cigarette will be rejected, even though perfectly good. In other words, it cannot be guaranteed *a priori* that an error signal generated by the device effectively indicates a defective cigarette on every occasion.

The drawback in question is highlighted especially in dusty surroundings, such as those in which a cigarette manufacturing machine will typically operate.

The object of the invention is to provide a method of monitoring the external integrity of cigarettes such as will remain free of the drawback described above.

The stated object is realized according to the present invention in a method for monitoring the external integrity of cigarettes that comprises the steps of advancing cigarettes in a predetermined feed direction by means of a conveyor, each accommodated within a respective seat afforded by the conveyor and following a path of which one section is a monitoring path, and examining each cigarette in respect of its external characteristics while in movement along the monitoring path, characterized in that the step of examining the external characteristics of the cigarettes is effected using at least one set of multiline optical scanning means positioned along the monitoring path, such as will execute a plurality of pulsed optical scans at successive intervals; in that each discrete optical scan coincides with one of a cluster of corresponding parallel lines disposed one alongside another; and in that each cigarette is examined by scanning a given generator of its cylindrical surface more than once on different lines succeeding one another sequentially and synchronously with the movement of the cigarette along the monitoring path in the feed direction.

The stated object is realized similarly, according to the present invention, in a device for implementation of the method described above.

A device according to the invention for monitoring the external integrity of cigarettes comprises a conveyor affording a plurality of seats caused to advance in a feed direction along a predetermined path, of which one section is a monitoring path, each accommodating a respective cigarette disposed with its longitudinal axis transverse to the feed direction, and at least one set of optical scanning means positioned along the monitoring path and designed to examine the external characteristics of at least one generator presented by each cigarette advancing along the monitoring path, characterized in that the optical scanning means are of a multiline type such as will execute a plurality of discrete scans on a respective plurality of lines disposed parallel with and alongside one another in a cluster; also, in that it comprises timing means by which the operation of the optical scanning means is synchronized with the movement of the conveyor in such a way that the plurality of scans will fall on one and the same generator of each advancing cigarette.

In a preferred embodiment, optical scanning means will comprise at least one solid state camera utilizing a CCD array and capable of multiline scanning (referred to conventionally as a Time Delay and Integration Line Scan Camera).

The invention will now be described in detail, by way of example, with the aid of the accompanying drawings, in which:

- fig 1 illustrates a preferred embodiment of the monitoring device according to the present invention, viewed schematically and in elevation;
- fig 2 illustrates a detail of the device of fig 1, shown enlarged and in successive steps of operation. With reference to the accompanying drawings, 1 denotes a device, in its entirety, for verifying the exter-

nal integrity of cigarettes 2; such a device comprises a cigarette conveyor 3 equipped with a transfer wheel 4 (conventional in embodiment) forming part of a filter tipping machine. The manufactured cigarettes 2 are fed singly and in succession to the transfer wheel 4 by an infeed wheel 5, then taken up and distanced following verification by an outfeed wheel 6 The various wheels are driven in rotation about their respective axes by means of conventional embodiment not indicated in the drawings.

The transfer wheel 4 affords a plurality of peripheral seats 7, each designed to accommodate and to retain a respective cigarette 2, such as can be advanced by the wheel 4 in a feed direction denoted F1 (clockwise as viewed in fig 1) along a circular path 13 of which one section is a monitoring path 8 Also forming part of the transfer wheel 4 are means not illustrated in the drawings, but of conventional design (as disclosed for example in US Patent 5 237 524 to which reference may be made for a fuller description) such as will engage the two longitudinal extremities of each cigarette 2 occupying a respective seat 7 and induce a rotation F2 of the cigarette about its own longitudinal axis. Each cigarette 2 is therefore able to describe a controlled trajectory composed of a translational movement in the feed direction F1 along the monitoring path 8, and a rotation F2 about its own longitudinal axis

The device 1 comprises means by which to examine the external characteristics presented by at least one generator 2a of each cigarette 2 advancing along the monitoring path 8 Such means consist essentially in optical scanning means 9 of conventional type such as will execute a plurality of optical readings or scans on respective lines 10 extending parallel to the axes of the cigarettes 2

The single scan lines 10 are disposed parallel with and alongside one another, forming a cluster generated substantially in alignment with the direction along which the cigarettes 2 advance The optical scans are discrete, pulsed sequentially and at a predetermined frequency to coincide with each line 10 of the cluster from the first through to the last As the description will show in due course, the optical scanning means 9 are able to examine a given straight line generator 2a of each cigarette 2 several times, the generator being for practical purposes an extremely small portion of the cylindrical surface exhibited by the cigarette 2, appearing substantially rectangular in plan and having a longitudinal dimension equal to the length of the cigarette 2.

The optical scanning means 9 preferably comprise at least one solid state camera 11 incorporating an array of charge-coupled devices (of a type known to persons skilled in the art as a Time Delay & Integration Line Scan Camera) such as will generate a beam comprising a plurality (typically 96) of discrete scans pulsed in succession and coinciding with the respective lines 10 aforementioned. The width of a single scan line 10 is of the order of a few micrometres, whilst the overall width of the lines generated by the camera 11 in each burst will be greater than the width of the individual line 10 by a factor of at least one or two.

In the solution described and illustrated, use is made of three TDI type line scan cameras 11 spaced apart one from the other along the monitoring path 8, each camera 11 serving to monitor a relative generator 2a, 2b and 2c of the cigarette 2, as will become clear in due course.

The device 1 preferably comprises timing means 14 of conventional embodiment, illustrated schematically in fig 1, by which the movement of the cigarettes 2 along the monitoring path 8 (to reiterate, translated along the feed direction F1 by the transfer wheel 4 while in rotation F2 about their individual longitudinal axes) can be synchronized with the scanning frequency of the cameras 11 in such a way that the cluster of lines 10 scanned in a typical burst by any one camera 11 will always fall substantially on the same generator 2a of the cigarette 2 advancing at a given moment past that camera 11. Thus, the timing means 14 control both the transfer wheel 4 and the means by which the individual cigarettes 2 are made to rotate about their own axis. When, in operation of the device, a given generator 2a of an advancing cigarette 2 is rotated exactly into alignment with the first of the cluster of lines 10 relative to the first camera 11, this same camera will begin scanning With the cigarette 2 then continuing to advance and to rotate (in the direction denoted F2) the same generator 2a (i. e. that already scanned on the first line) will be brought exactly into alignment with the second line 10 of the cluster, whereupon the first camera 11 makes a second scan; and so on for the remaining lines 10 of the cluster.

Given that the lines 10 of the cluster will be scanned typically at a rate (expressible mathematically as the distance between any two adjacent lines 10 multiplied by the frequency of the scan pulses) faster than the velocity at which the cigarettes 2 advance in the feed direction F1 along the monitoring path 8, it follows that if a cigarette 2 were not rotated about its axis, there would be a built-in delay relative to the scan pulses and each successive scan would therefore fall on a different generator. Precisely in order to avoid such a situation, the cigarette 2 is made to rotate about its own axis in the same direction of rotation as that described by the transfer wheel 4 (see fig 2), so that the single generator being scanned can keep pace positionally with the pulses. Fig 2 indicates the positions assumed successively by the cigarette 2 in relation to three different scan lines 10 during the burst generated by a given camera 11.

Each image scanned is compared by the device 1 with a reference image in the usual manner. In the event of the space between a given camera 11 and a cigarette 2 being invaded by one or more foreign bodies (specks of dust, particles of tobacco filler, etc.), then certain of the scans made by that camera could produce images

dissimilar to the reference image due to the presence of such matter (and not by reason of any real defect in the cigarette 2). This need not necessarily result in the rejection of the cigarette 2, however, since the majority of the scans will not be affected by the presence of particulates: indeed the typical size of any particle liable to be detected is much less than the overall width of the cluster of lines 10 scanned by a camera 11 in one burst.

The requisite number of scans having been completed, the device 1 proceeds to determine the ratio between those resulting "positive", that is to say reflecting an irregularity in the cigarette 2 and those which are "negative"; in the event of the ratio exceeding a preset value (reprogrammable), the device 1 responds in conventional manner by generating an output signal such as might be utilized, for example, to pilot the operation of a reject device (not illustrated) located further along the manufacturing line. Once beyond the first camera, and before reaching the second camera, the single cigarette 2 can be rotated about its own axis (for example through 120°) in such a way that the second camera will scan a different generator of the cigarette 2, denoted 2b in fig 1, whereupon the cycle of operations described above is repeated.

Thereafter, these same operations are again repeated by the third camera on a third generator, denoted 2c in the example illustrated.

Clearly, it would be possible to use a greater number of cameras 11 installed along the monitoring path 8, so that different generators of each cigarette 2 can be examined, though still with each camera scanning a single generator several times.

The facility of causing a cigarette 2 to rotate in the direction denoted F2 about its own axis serves a dual function: first, the movement of the cigarette 2 can be synchronized with the operation of a camera 11 set up to scan a plurality of lines 10, so that a given generator can be examined several times by the one camera with no need to adopt an excessive peripheral velocity of the transfer wheel 4; second, it becomes possible also to sample several generators of the same cigarette 2.

Finally, and still with a high level of dependability in quality control as the aim, the sampling of single generators by repeated scanning (as defined in the foregoing description) can be extended in accordance with the present invention to compass any given number of generators, and therefore a portion of any width presented by the cylindrical surface of the single cigarette.

Claims

1. A method for monitoring the external integrity of cigarettes, comprising the steps of advancing single cigarettes (2) in a predetermined feed direction (F1) by means of a conveyor (3) each accommodated within a respective seat (7) afforded by the conveyor (3) and made to follow a path (13) of which one section is a monitoring path (8), and examining each cigarette (2) in respect of its external characteristics while in movement along the monitoring path (8), characterized

   - in that the step of examining the external characteristics of the cigarettes (2) is effected using at least one set of multiline optical scanning means (9) positioned along the monitoring path (8), such as will execute a plurality of pulsed optical scans at successive intervals;
   - in that each discrete optical scan coincides with one of a cluster of corresponding parallel lines (10) disposed one alongside another; and,
   - in that each cigarette (2) is examined by scanning a given generator (2a) of its cylindrical surface more than once on different parallel lines (10) succeeding one another sequentially and synchronously with the movement of the cigarette (2) along the monitoring path (8) in the feed direction (F1).

2. A method as in claim 1, comprising the further steps of enforcing a rotation (F2) of each cigarette (2) about its own longitudinal axis in a given direction at least when crossing the scan lines (10), and of synchronizing the scan lines (10) with the movements of the cigarette (2) along the feed direction (F1) and in rotation (F2) about its own axis in such a way that the same generator (2a) is scanned repeatedly.

3. A method as in claim 1 or 2, wherein the optical scanning means (9) comprise at least one solid state camera (11) capable of multiline scanning.

4. A method as in preceding claims wherein use is made of a plurality of optical scanning means (9) distributed along the monitoring path (8), comprising the further step of causing the cigarette (2) to rotate about its own longitudinal axis when advancing between one set of optical scanning means (9) and the next in order to allow the examination of more than one generator (2a, 2b...) presented by each cigarette (2).

5. A device for monitoring the external integrity of cigarettes, comprising: a conveyor (3) affording a plurality of seats (7) caused to advance in a feed direction (F1) along a predetermined path of which one section is a monitoring path (8), each accommodating a relative cigarette (2) disposed with its longitudinal axis transverse to the feed direction (F1); at least one set of optical scanning means (9) positioned along the monitoring path (8) and designed to examine the external characteristics of at least one generator (2a) presented by each cigarette (2) advancing along the monitoring path (8).

characterized

- in that the optical scanning means (9) are of a multiline type such as will execute a plurality of discrete scans on a respective plurality of lines (10) disposed parallel with and alongside one another in a cluster, and
- in that it comprises timing means (14) by which the operation of the optical scanning means (9) is synchronized with the movement of the conveyor (3) in such a way that the plurality of scans will fall on one and the same generator (2a, 2b, 2c) of each advancing cigarette (2).

6. A device as in claim 5, wherein the conveyor (3) comprises a transfer wheel (4) rotatable about its own axis, of which the periphery affords a plurality of seats (7) accommodating the cigarettes (2), and means operating synchronously with the optical scanning means (9) by which each cigarette (2) occupying a respective seat (7) is caused to rotate about its own longitudinal axis when crossing the scan lines (10).

7. A device as in claim 5 or 6, wherein the optical scanning means (9) comprise at least one solid state camera (11) capable of multiline scanning.

8. A device as in preceding claims, comprising a plurality of optical scanning means (9) distributed along the monitoring path (E), serving in operation respectively to examine a single generator (2a, 2b, 2c) of each advancing cigarette (2), also means of conventional embodiment by which each cigarette (2) occupying a respective seat (7) is caused to rotate about its own longitudinal axis when advancing between one set of optical scanning means (9) and the next.

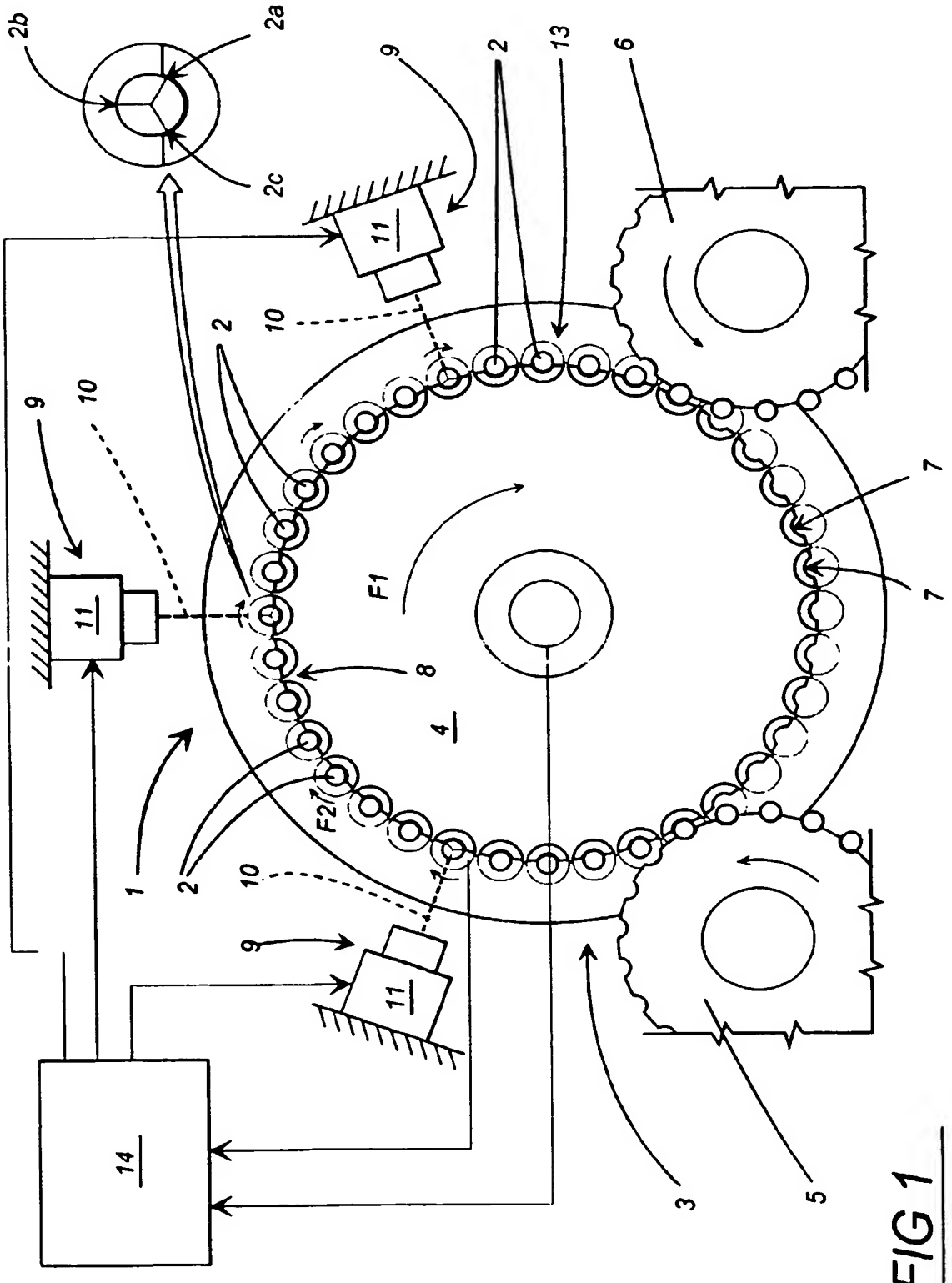
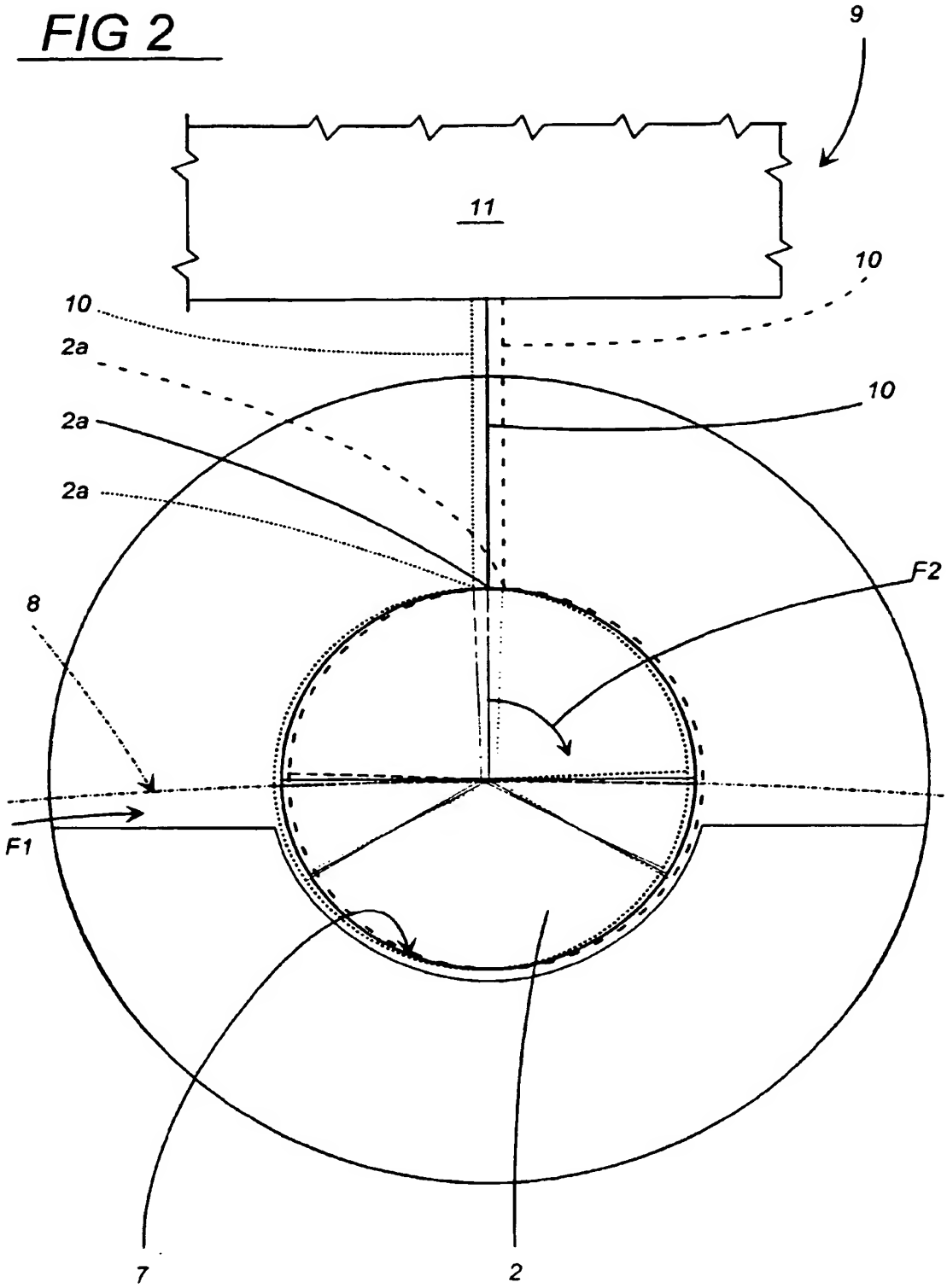


FIG 1

FIG 2



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EUROPEAN SEARCH REPORT

Application Number
EP 97 83 0280 .0

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	GB 2 267 474 A (KORBER AG) * the whole document *	1,2,5,6	A24C5/34 G01N21/88
A	EP 0 570 163 A (PHILIP MORRIS PRODUCTS INC.) * the whole document *	1,5	
A	EP 0 545 695 A (JAPAN TOBACCO INC.) * the whole document *	1,5	
A	DE 30 30 140 A (B.A.T. CIGARETTEN-FABRIKEN GMBH) * the whole document *	1,5	
A	GB 2 201 326 A (KORBER AG) * page 23, line 19 - page 25, line 5; figure 4 *	1,5	
A	DE 36 28 086 A (B.A.T. CIGARETTEN-FABRIKEN GMBH)		
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10 September 1997	Riegel, R

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